

ϕ -meson Reconstruction in the STAR TPC

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The measurement of ϕ -meson production in heavy ion collisions is interesting, not only because the ϕ contains hidden strangeness, whose production is suppressed in nucleon-nucleon interaction by the OZI rule,¹ but also because it could be a probe to the restoration of chiral symmetry in matter produced in heavy ion collisions. In particular, the ratio of ϕ to K^- serves as a much cleaner probe than the K^+ to π^+ ratio because very few resonances decay into kaons compared to pions.

We investigate the feasibility of reconstructing the ϕ through its K^+K^- decay channel in the STAR TPC, using the full STAR software chain. For the present study, we used 683 Au+Au central events generated by RQMD (v2.4) at an impact parameter $b < 4$ fm and center-of-mass energy $\sqrt{s} = 200$ GeV. The ϕ 's were not decayed in the model. The events were fed into a GEANT simulation of the STAR detector (**gstar**), and the ϕ 's were decayed by GEANT. Using the GEANT output, hits were simulated by the TPC fast simulator (**tfs**) to include the detector response. Tracks were reconstructed from the hits by the TPC track reconstruction program (**tpt**). Specific ionization energies deposited by charged particles in the TPC gas (dE/dx) were calculated by the TPC particle identification package (**tid**). The version used for **tfs**, **tpt** and **tid** is 98d.

We use dE/dx to identify kaons. We have studied two PID cuts: tight PID in which kaons are exclusively identified up to a momentum about 0.6 GeV/c, and loose PID in which momentum cut is relaxed to 1 GeV/c allowing some contamination from the pions in the momentum range $0.6 < p < 1$ GeV/c. For the tight PID, about 30 K^+ 's and K^- 's each were identified; for the loose PID, about 60 K^+ 's and K^- 's each were identified. The invariant-mass spectra for

the loose PID is shown in Figure 1. The mass resolution is 2.7 MeV/c² for both PID cuts. The signal-to-noise ratios are 1/13 and 1/12, respectively for the tight and loose PID. Numbers of ϕ 's per event reconstructed are 0.8 and 1.3 for the tight and loose PID, respectively. About 5.8 ϕ 's per event that are generated by RQMD decay into K^+K^- within rapidity $-1.5 < y < 1.5$ (the TPC acceptance) and momentum $p < 1$ GeV/c. We emphasize that the mass resolution from both PID cuts is the same, and the signal-to-noise ratio does not worsen (even increases) from the tight PID to the loose PID, with significant gain in the number of reconstructed ϕ 's.

ϕ from gstar+tfs+tpt+tid+tte RQMD Au+Au ($b < 4$ fm) at RHIC

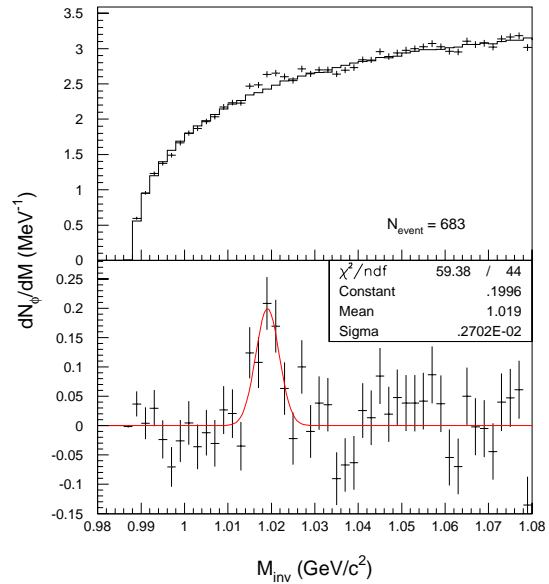


Figure 1: Top: invariant-mass spectrum of K^+K^- pairs calculated from reconstructed kaon momenta, with kaons identified by the loose PID. ϕ 's are decayed inside GEANT. The ϕ intrinsic mass width is not included in the decays. Bottom: signal obtained after background subtraction. The background (shown as the histogram in the top panel) was obtained by pairing oppositely charged kaons from different events and normalized to the invariant-mass spectrum by the total number of entries. The curve is a Gaussian fit to the signal.

Footnotes and References

¹Susumu Okubo, Phys. Rev. Lett. **5**, 165 (1963); Susumu Okubo, Phys. Rev. D **16**, 2336 (1977); J. Iizuka, Prog. Theor. Phys. **35**, 1061 (1966), **37** & **38**, 21 (1966).